Chapter 5

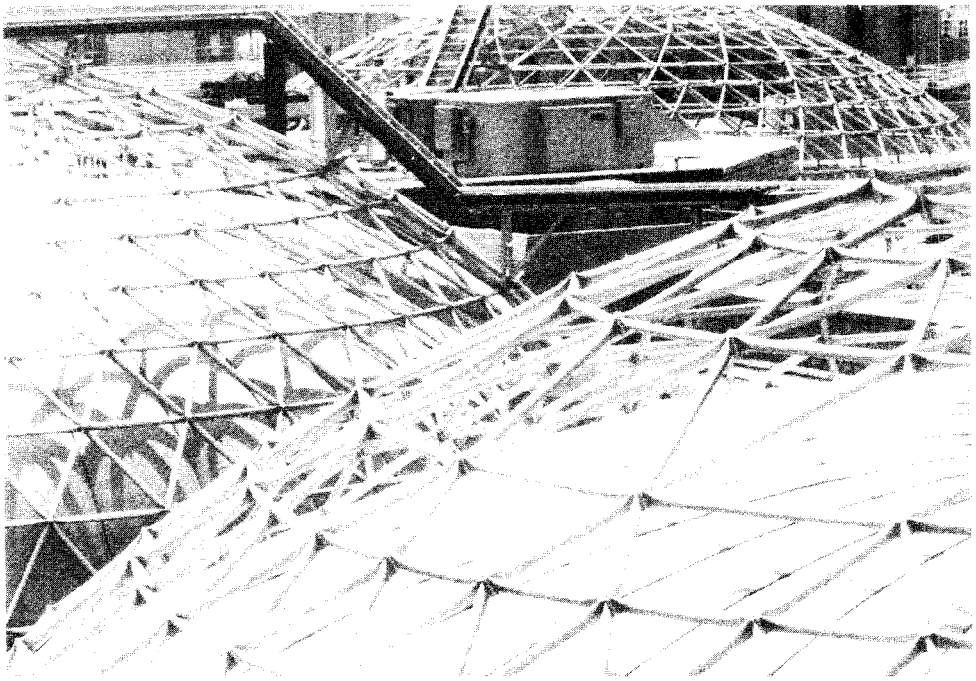
Pathogen and Vector Attraction Reduction Requirements

Why Are There Pathogen and Vector Attraction Reduction Requirements?

Pathogens are disease-causing organisms, such as certain bacteria, viruses, and parasites. Vectors are organisms, such as rodents and insects, that can spread disease by carrying and transferring pathogens. Subpart D of the Part 503 rule covers alternatives for reducing pathogens in biosolids (including domestic septage), as well as options for reducing the potential for biosolids to attract vectors.

The Subpart D alternatives concern the designation of biosolids as "Class A" or "Class B" in regard to pathogens. These classifications indicate the density (numbers/unit mass) of pathogens in biosolids where applicable. The requirements for land application or surface disposal of biosolids vary depending on the class of pathogen reduction achieved. Biosolids have to meet applicable requirements for both pathogen and vector attraction reduction to be in compliance with the rule.

This chapter describes the pathogen alternatives and vector attraction reduction options in the Part 503 rule. For more detail, the reader is referred to an EPA publication entitled, ***Control of Pathogens and Vector Attraction in Sewage Sludge*** (EPA/625/R-92/013), December 1992.



Anaerobic digesters in Columbus, Ohio, reduce pathogens and vector attraction to produce Class B biosolids.

To Whom Do These Requirements Apply?

The pathogen and vector attraction reduction requirements in Subpart D of the Part 503 rule apply to biosolids, including domestic septage, and their application to or placement on the land for beneficial use or disposal. Domestic septage applied to nonpublic contact sites (i.e., agricultural land, forests, and reclamation sites) is covered by a simplified portion of the rule that is explained in a separate EPA guidance document (***Domestic Septage Regulatory Guidance: A Guide to the EPA 503 Rule***, EPA/832-B-92-005).

Depending on how biosolids are used or disposed and which pathogen alternative and vector attraction reduction option are relied on, compliance with the pathogen and vector attraction requirements of Subpart D is the responsibility of persons who:

generate biosolids that are either land applied or surface disposed;

derive a material from biosolids that are either land applied or surface disposed;

apply biosolids to the land;

place biosolids on a surface disposal site; and

own or operate a surface disposal site.

Pathogen Reduction Alternatives

The Part 503 pathogen reduction alternatives ensure that pathogen levels in biosolids are reduced to levels considered safe for the biosolids to be land applied or surface disposed. Subpart D includes criteria to classify biosolids as Class A or Class B with respect to pathogens. These classifications are based on the level of pathogens present in biosolids that are used or disposed.

If pathogens (*Salmonella* sp. bacteria, enteric viruses, and viable helminth ova) are below detectable levels, the biosolids meet the Class A designation. Biosolids are designated Class B if pathogens are detectable but have been reduced to levels that do not pose a threat to public health and the environment as long as actions are taken to prevent exposure to the biosolids after their use or disposal. When Class B biosolids are land applied, certain restrictions must be met at the application site; other requirements have to be met when Class B biosolids are surface disposed. The land application restrictions allow natural processes to further reduce pathogens in the biosolids before the public has access to the site. In general, Class A corresponds to the existing 40 CFR Part 257 "Process to Further Reduce Pathogens (PFRP)" designation, and Class B roughly corresponds to the existing 40 CFR Part 257 "Process to Significantly Reduce Pathogens (PSRP)" designation. There are several important differences in approach between the existing Part 257 and the new Part 503 requirements for pathogen and vector attraction reduction:

1 Whereas Part 257 required the use of specifically listed or approved treatment technologies to treat biosolids, the Part 503 rule provides flexibility in how the pathogen and vector attraction reduction requirements are met. The pathogen reduction requirements of the Part 503 rule can be met either by:

- —using certain specified technologies to treat the biosolids as before, or
- —showing that the quality of the biosolids meets certain performance results.

2 The Part 503 rule requires either pathogen or pathogen indicator measurements for all Class A alternatives and pathogen indicator measurements for the first of the three Class B alternatives.

3 The Part 503 rule separates pathogen reduction requirements from vector attraction reduction requirements, as follows:

- —The Class A and B designations refer only to the reductions achieved in pathogens.

—Vector attraction reduction is governed by a separate set of requirements described in a later section of this chapter.

—There is, however, still a requirement that both pathogen and vector attraction reduction requirements be met, and for Class A biosolids the pathogen reduction requirements must be met before or at the same time as most of the vector attraction reduction requirements, thereby minimizing the potential for regrowth of pathogenic bacteria.

Class A Pathogen Requirements

The Part 503 rule lists six alternatives for treating biosolids so they can be classified Class A with respect to pathogens. These alternatives are summarized in Table 5-1 and are discussed in detail below. Any one of these six alternatives may be met for the biosolids to be deemed Class A. Two of these alternatives follow closely with 40 CFR Part 257 pathogen requirements by allowing use of PFRPs and equivalent technologies.

TABLE 5-1
Summary of the Six Alternatives for Meeting Class A Pathogen Requirements

In addition to meeting the requirements in one of the six alternatives listed below, the requirements in Table 5-2 must be met for all six Class A alternatives.

Alternative 1: Thermally Treated Biosolids

Biosolids must be subjected to one of four time-temperature regimes.

Alternative 2: Biosolids Treated in a High pH-High Temperature Process

Biosolids must meet specific pH, temperature, and air-drying requirements.

Alternative 3: Biosolids Treated in Other Processes

Demonstrate that the process can reduce enteric viruses and viable helminth ova. Maintain operating conditions used in the demonstration after pathogen reduction demonstration is completed.

Alternative 4: Biosolids Treated in Unknown Processes

Biosolids must be tested for pathogens—*Salmonella* sp. or fecal coliform bacteria, enteric viruses, and viable helminth ova—at the time the biosolids are used or disposed, or, in certain situations, prepared for use or disposal.

Alternative 5: Biosolids Treated in a PFRP

Biosolids must be treated in one of the Processes to Further Reduce Pathogens (PFRP) (see Table 5-4).

Alternative 6: Biosolids Treated in a Process Equivalent to a PFRP

Biosolids must be treated in a process equivalent to one of the PFRPs, as determined by the permitting authority.

Table 5-2 lists several requirements that must be met for all six of the Class A alternatives. Perhaps the most significant of the requirements is to avoid regrowth of bacteria as indicated by the results of a fecal coliform or *Salmonella* test.

Alternative 1 for Meeting Class A: Thermally Treated Biosolids

This alternative applies when specific thermal heating procedures are used to reduce pathogens. Equations are used to determine the length of heating time at a given temperature needed to obtain Class A pathogen reduction (i.e., reduce the pathogen content to below detectable levels). The equations take into consideration the solid-liquid nature of the biosolids being heated, along with the particle size and how particles are brought into contact with the heat. The equations also take into consideration that the internal structure of the mixture can inhibit mixing. For example, a safety factor is included in the equation for Regime C (see Table 5-3) that adds more time for heating because less information is available about operational parameters that could influence the degree of pathogen destruction per unit of heat input. The rule identifies and provides equations for four different acceptable heating regimes.

The minimum indicated boundary conditions (i.e., solids content, mixing with the heat source, time of heating, and operating temperature) are given

TABLE 5-2
Pathogen Requirements for All Class A Alternatives

The following requirements must be met for ***all*** six Class A pathogen alternatives.

Either:

the density of fecal coliform in the biosolids must be less than 1,000 most probable numbers (MPN) per gram total solids (dry-weight basis),

or

the density of *Salmonella* sp. bacteria in the biosolids must be less than 3 MPN per 4 grams of total solids (dry-weight basis).

Either of these requirements must be met at one of the following times:

- when the biosolids are used or disposed;
- when the biosolids are prepared for sale or give-away in a bag or other container for land application; or
- when the biosolids or derived materials are prepared to meet the requirements for EQ biosolids (see Chapter 2).

Pathogen reduction must take place before or at the same time as vector attraction reduction, except when the pH adjustment, percent solids vector attraction, injection, or incorporation options are met.

below for each of the four thermal heating regimes. Any one of these four thermal heating regimes may be used. The equation specified for a particular heating regime is then used to calculate the actual time and temperature for operating the system within the boundaries of the applicable regime. In addition to the requirements for each regime, the requirements in Table 5-2 must be met.

The four regimes are listed in Table 5-3; some example calculations follow.

Example 1: Biosolids contain 10 percent solids and are heated with a biosolids dryer at 55°C. What is the required minimum time for achieving Class A pathogen status? The minimum time would be 63 hours if the operator followed Regime A in Table 5-3. Under Regime A the temperature cannot be lower than 50°C or the time shorter than 20 minutes.

$$Time = \frac{131{,}700{,}000}{10^{0.14\,(temperature)}} = \frac{131{,}700{,}000}{10^{0.14\,(55)}} = \frac{131{,}700{,}000}{50{,}118{,}723} = 2.6\ days\ [63\ hours]$$

TABLE 5-3
The Four Time-Temperature Regimes for Class A Pathogen Reduction Under Alternative 1

Regime	Applies to:	Requirement	Time-Temperature Relationship*
A	Biosolids with 7% solids or greater (except those covered by Regime B)	Temperature of biosolids must be 50°C or higher for 20 minutes or longer	$D = \frac{131{,}700{,}000}{10^{0.14t}}$ (Equation 2 of Section 503.32)
B	Biosolids with 7% solids or greater in the form of small particles and heated by contact with either warmed gases or an immiscible liquid	Temperature of biosolids must be 50°C or higher for 15 seconds or longer	$D = \frac{131{,}700{,}000}{10^{0.14t}}$
C	Biosolids with less than 7% solids	Heated for at least 15 seconds but less than 30 minutes	$D = \frac{131{,}700{,}000}{10^{0.14t}}$
D	Biosolids with less than 7% solids	Temperature of sludge is 50°C or higher with at least 30 minutes or longer contact time	$D = \frac{50{,}070{,}000}{10^{0.14t}}$ (Equation 3 of Section 503.32)

* D = time in days; t = temperature in degrees Celsius.

Example 2: Biosolids contain 10 percent solids and are treated in a biosolids dryer for about 1.5 minutes (0.001 day). What is the required minimum temperature? The minimum temperature to achieve Class A pathogen status would be 79°C if the operator followed Regime B in Table 5-3. Under this regime, the temperature cannot be lower than 50°C or the time shorter than 15 seconds and the biosolids must be in the form of small particles (e.g., from a steam drier) in intimate contact with the drying unit. Otherwise, Regime A would apply.

$$Time = \frac{131{,}700{,}000}{10^{0.14\ (temperature)}} = 0.001$$

$$0.001\ [10^{0.14\ (temp)}] = 131{,}700{,}000$$

$$Temperature = 79^{o}C$$

Alternative 2 for Meeting Class A: Biosolids Treated in a High pH–High Temperature Process

This alternative describes conditions of a specific temperature–pH process that is effective in reducing pathogens to below detectable levels. The process conditions required by the regulation are:

elevating the pH to greater than 12 (measured at 25°C) for 72 hours or longer;

maintaining the temperature above 52°C for at least 12 hours during the period that the pH is greater than 12;

air drying to over 50 percent solids after the 72-hour period of elevated pH; and

meeting all the requirements in Table 5-2.

Alternative 3 for Meeting Class A: Biosolids Treated in Other Known Processes

This alternative requires comprehensive monitoring of enteric viruses and viable helminth ova during each monitoring episode until demonstration has shown that the process achieves adequate reduction of pathogens. The presence of enteric viruses and viable helminth ova have to be shown in the biosolids prior to pathogen treatment to document the effectiveness of the treatment process.

The tests and requirements are:

Once shown to be present prior to treatment, the density of enteric viruses in the biosolids after pathogen treatment must be less than 1 plaque- forming unit (PFU) per 4 grams of total solids (dry-weight basis).

Likewise, the density of viable helminth ova in the biosolids after pathogen treatment must be less than 1 per 4 grams of total solids (dry-weight basis).

All the requirements in Table 5-2 must be met.

Acceptable pathogen testing procedures are given in Chapter 6 and in the document ***Control of Pathogens and Vector Attraction in Sewage Sludge*** noted earlier in this chapter.

Alternative 3 is useful for demonstrating that a new process fully meets Class A pathogen requirements under the tested set of operating parameters. Subsequent testing for enteric viruses and viable helminth ova is unnecessary whenever the tested set of operating parameters has been met. It is important to realize that the tested set of operating parameters may have included ranges of values.

If no enteric viruses or viable helminth ova are present before treatment, then the tested batch of biosolids can be considered Class A. The tests, however, must be repeated during each subsequent monitoring episode until:

pathogens are detected before the process and demonstrated to have been reduced to below detectable levels after the process, or

after 2 years of testing with no detection of pathogens before the process, the permitting authority modifies the monitoring requirements for enteric viruses and viable helminth ova. (The permitting authority may choose not to modify the monitoring requirements, but if it does, in no case could the monitoring frequency for enteric viruses and viable helminth ova be less than once per year.)

Once the process has been demonstrated to process achieve the required pathogen reduction, the process must be operated under the same conditions that were used during the demonstration.

As already mentioned, monitoring for fecal coliform or *Salmonella* sp. bacteria is always required in accordance with the requirements listed in Table 5-2.

Alternative 4 for Meeting Class A: Biosolids Treated in Unknown Processes

This alternative is used in situations where:

a biosolids treatment process is unknown, or

the biosolids were treated in a process operating under less-stringent conditions than those under which the biosolids could qualify as Class A under any of the other alternatives.

This alternative requires that the biosolids be analyzed for *Salmonella* sp. bacteria, enteric viruses, and viable helminth ova at each of the following times:

- when the biosolids (or materials derived from biosolids) are used or disposed;
- when biosolids are prepared for sale or for give-away in a bag or other container for application to the land; or
- when the biosolids are prepared to meet the EQ requirements (see Chapter 2).

As in Alternative 3, the required test results for this alternative are:

- The density of viruses in the biosolids must be less than 1 PFU per 4 grams of total solids (dry-weight basis).
- The density of viable helminth ova in the biosolids must be less than 1 per 4 grams of total solids (dry-weight basis).
- All the requirements in Table 5-2 must be met.

Although biosolids must meet the same pathogen test results as in Alternative 3, Alternative 4 requires testing of each batch of the biosolids that is used or disposed, rather than just monitoring the operating parameters, after the demonstration that the process reduces pathogens.

Alternative 5 for Meeting Class A: Biosolids Treated in a PFRP

Alternative 5 provides continuity with the 40 CFR Part 257 regulation. This alternative states that biosolids are considered to be Class A if:

- they are treated in one of the PFRPs listed in Table 5-4, and
- all requirements in Table 5-2 are met.

To meet these requirements, the biosolids treatment processes must be operated according to the conditions listed in Table 5-4. This list is very similar to the list of PFRP technologies in 40 CFR Part 257, with two major differences:

- All requirements related to vector attraction reduction have been removed (see the vector attraction reduction requirements discussed later in this chapter).
- The three processes listed in Part 257 that are PFRP only if combined with a PSRP (gamma ray irradiation, high-energy irradiation, and pasteurization) are PFRPs under Part 503.

Under this alternative, treatment processes classified under 40 CFR Part 257 can continue to be operated; however, microbiological monitoring (as described in Table 5-2) must now be performed to ensure that pathogen density levels are below detection limits and that pathogen regrowth has not resulted in detectable levels being present at the time of use or disposal.

TABLE 5-4
Processes to Further Reduce Pathogens (PFRPs) Listed in Appendix B of 40 CFR Part 503

1. Composting

Using either the within-vessel composting method or the static aerated pile composting method, the temperature of the biosolids is maintained at 55°C or higher for 3 days.

Using the windrow composting method, the temperature of the biosolids is maintained at 55°C or higher for 15 days or longer. During the period when the compost is maintained at 55°C or higher, the windrow is turned a minimum of five times.

2. Heat Drying

Biosolids are dried by direct or indirect contact with hot gases to reduce the moisture content of the biosolids to 10 percent or lower. Either the temperature of the biosolids particles exceeds 80°C or the wet bulb temperature of the gas in contact with the biosolids as the biosolids leave the dryer exceeds 80°C.

3. Heat Treatment

Liquid biosolids are heated to a temperature of 180°C or higher for 30 minutes.

4. Thermophilic Aerobic Digestion

Liquid biosolids are agitated with air or oxygen to maintain aerobic conditions, and the mean cell residence time of the biosolids is 10 days at 55° to 60°C.

5. Beta Ray Irradiation

Biosolids are irradiated with beta rays from an accelerator at dosages of at least 1.0 megarad at room temperature (ca. 20°C).

6. Gamma Ray Irradiation

Biosolids are irradiated with gamma rays from certain isotopes, such as Cobalt 60 and Cesium 137, at room temperature (ca. 20°C).

7. Pasteurization

The temperature of the biosolids is maintained at 70°C or higher for 30 minutes or longer.

Alternative 6 for Meeting Class A: Biosolids Treated in a Process Equivalent to a PFRP

Under Alternative 6, biosolids are considered to be Class A if:

- they are treated by any process determined to be equivalent to a PFRP by the permitting authority, and
- all requirements in Table 5-2 are met.

Composting can eliminate pathogens in biosolids (Columbus, Ohio).

The Part 503 rule gives the permitting authority responsibility for determining equivalency. To be equivalent, a treatment process must be able *to* ***consistently reduce*** pathogens to levels comparable to the reduction achieved by listed PFRPs. The process must be equivalent in its ability to achieve Class A status with respect to enteric viruses and viable helminth ova as long as it is operated under the same conditions that produced the required reductions.

Equivalency determinations can be made both on a site-specific and a national basis. A site-specific equivalency determination only pertains to one particular operation run at one location under the specified conditions. It cannot be assumed to apply to the same process performed at a different location, or for any modification of the process. A process that is able to consistently produce the required pathogen reductions at different locations across the country, however, may qualify for a recommendation of national equivalency (i.e., a recommendation that the process will likely be equivalent wherever it is operated in the United States).

The EPA's Pathogen Equivalency Committee (PEC) is available as a resource to provide recommendations on equivalency determinations to the permitting authority and guidance to the regulated community. See ***Control of Pathogens and Vector Attraction in Sewage Sludge*** (noted earlier in this chapter) for more details about the PEC.

Class B Pathogen Requirements

Class B pathogen requirements can be met using one of three alternatives, as listed in Table 5-5 and described below. Unlike a Class A biosolids, in which pathogens are at levels below detectable limits, Class B biosolids may contain some pathogens. For this reason, the Class B requirements for land application of biosolids also include site restrictions that prevent crop harvesting, animal grazing, and public access for a certain period of time until environmental conditions have further reduced pathogens. The land application site restrictions for Class B biosolids are summarized in Table 5-6. Management practices rather than site restrictions prevent exposure to the pathogens in biosolids for surface disposed Class B biosolids.

Alternative 1 for Meeting Class B: The Monitoring of Indicator Organisms

Alternative 1 requires that seven samples of treated biosolids be collected shortly before biosolids use or disposal, ***and*** that the geometric mean fecal coliform density of these samples be less than 2 million colony-forming units (CFU) or most probable number (MPN) per gram of biosolids (dry-weight basis). EPA suggests that these seven samples be collected over a 2-week period. This approach uses fecal coliform density as an indicator of the average density of bacterial and viral pathogens. Acceptable pathogen testing procedures are given in Chapter 6.

EPA recommends that seven samples be taken over the 2-week period preceding use or disposal because the test methods used to determine fecal coliform density (membrane filter methods and the multiple tube dilution method) have poor precision and biosolids quality can vary. Using at least seven samples should provide a sufficiently representative sampling of the biosolids.

TABLE 5-5
Summary of the Three Alternatives for Meeting Class B Pathogen Requirements

Alternative 1: The Monitoring of Indicator Organisms
Test for fecal coliform density as an indicator for all pathogens. The geometric mean of seven samples shall be less than 2 million MPNs per gram per total solids or less than 2 million CFUs per gram of total solids at the time of use or disposal.
Alternative 2: Biosolids Treated in a PSRP
Biosolids must be treated in one of the Processes to Significantly Reduce Pathogens (PSRP) (see Table 5-7).
Alternative 3: Biosolids Treated in a Process Equivalent to a PSRP
Biosolids must be treated in a process equivalent to one of the PSRPs, as determined by the permitting authority.

TABLE 5-6
Site Restrictions for Class B Biosolids Applied to the Land

Food Crops with Harvested Parts That Touch the Biosolids/Soil Mixture

Food crops with harvested parts that touch the biosolids/soil mixture and are totally above the land surface shall not be harvested for 14 months after application of biosolids.

Food Crops with Harvested Parts Below the Land Surface

Food crops with harvested parts below the surface of the land shall not be harvested for 20 months after application of biosolids when the biosolids remain on the land surface for 4 months or longer prior to incorporation into the soil.

Food crops with harvested parts below the surface of the land shall not be harvested for 38 months after application of biosolids when the biosolids remain on the land surface for less than 4 months prior to incorporation into the soil.

Food Crops with Harvested Parts That Do Not Touch the Biosolids/Soil Mixture, Feed Crops, and Fiber Crops

Food crops with harvested parts that do not touch the biosolids/soil mixture, feed crops, and fiber crops shall not be harvested for 30 days after application of biosolids.

Animal Grazing

Animals shall not be grazed on the land for 30 days after application of biosolids.

Turf Growing

Turf grown on land where biosolids are applied shall not be harvested for 1 year after application of the biosolids when the harvested turf is placed on either land with a high potential for public exposure or a lawn, unless otherwise specified by the permitting authority.

Public Access

Public access to land with a high potential for public exposure shall be restricted for 1 year after application of biosolids.

Public access to land with a low potential for public exposure shall be restricted for 30 days after application of biosolids.

Alternative 2 for Meeting Class B: Biosolids Treated in a PSRP

Class B Alternative 2 provides continuity with the 40 CFR Part 257 regulation. Under this alternative, biosolids are considered to be Class B if they are treated in one of the PSRPs listed in Table 5-7. The listed processes are similar to the PSRPs listed in the Part 257 regulation, except that all conditions related to reduction of vector attraction have been removed.

TABLE 5-7
Processes to Significantly Reduce Pathogens (PSRPs) Listed in Appendix B of 40 CFR Part 503

1. Aerobic Digestion

Biosolids are agitated with air or oxygen to maintain aerobic conditions for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 40 days at 20°C and 60 days at 15°C.

2. Air Drying

Biosolids are dried on sand beds or on paved or unpaved basins. The biosolids dry for a minimum of 3 months. During 2 of the 3 months, the ambient average daily temperature is above 0°C.

3. Anaerobic Digestion

Biosolids are treated in the absence of air for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 15 days at 35°C to 55°C and 60 days at 20°C.

4. Composting

Using either the within-vessel, static aerated pile, or windrow composting methods, the temperature of the biosolids is raised to 40°C or higher and maintained for 5 days. For 4 hours during the 5-day period, the temperature in the compost pile exceeds 55°C.

5. Lime Stabilization

Sufficient lime is added to the biosolids to raise the pH of the biosolids to 12 after 2 hours of contact.

Under this alternative, biosolids treated in processes included in 40 CFR Part 257 are Class B with respect to pathogens. Unlike the comparable Class A requirement, this alternative does not require microbiological monitoring for regrowth of fecal coliform or *Salmonella* sp. bacteria.

Alternative 3 for Meeting Class B: Biosolids Treated in a Process Equivalent to a PSRP

The Part 257 regulation allowed the biosolids to be treated in a process determined to be *equivalent to* a PSRP. Under Alternative 3, biosolids treated by any process determined to be equivalent to a PSRP by the permitting authority are considered to be Class B biosolids.

Part 503 gives the permitting authority responsibility for determining equivalency. The EPA Pathogen Equivalency Committee is available as a resource to provide recommendations on equivalency determinations to the permitting authorities. As with Class A, the Class B equivalency

determination can be made on either a site-specific or a national basis. See ***Control of Pathogens and Vector Attraction in Sewage Sludge*** (noted earlier in this chapter) for more details about the PEC.

Requirements for Reducing Vector Attraction

The pathogens in biosolids pose a disease risk when they are brought into contact with humans or other susceptible hosts (plant or animal). Vectors, which include flies, mosquitoes, fleas, rodents, and birds, can transmit pathogens to humans and other hosts physically through contact or biologically by playing a specific role in the life cycle of the pathogen. Reducing the attractiveness of biosolids to vectors reduces the potential for transmitting diseases from pathogens in biosolids.

The Part 503 rule contains 12 options, which are summarized in Table 5-8 and described below, for demonstrating reduced vector attraction for biosolids. (Note: Option 12 only applies to domestic septage.) These requirements are designed to either reduce the attractiveness of biosolids to vectors (Options 1 through 8 and Option 12) or prevent vectors from coming in contact with the biosolids (Options 9 through 11).

TABLE 5-8
Summary of Options for Meeting Vector Attraction Reduction

Option 1:	Meet 38 percent reduction in volatile solids content.
Option 2:	Demonstrate vector attraction reduction with additional anaerobic digestion in a bench-scale unit.
Option 3:	Demonstrate vector attraction reduction with additional aerobic digestion in a bench-scale unit.
Option 4:	Meet a specific oxygen uptake rate for aerobically digested biosolids.
Option 5:	Use aerobic processes at greater than 40°C for 14 days or longer.
Option 6:	Alkali addition under specified conditions.
Option 7:	Dry biosolids with no unstabilized solids to at least 75 percent solids.
Option 8:	Dry biosolids with unstabilized solids to at least 90 percent solids.
Option 9:	Inject biosolids beneath the soil surface.
Option 10:	Incorporate biosolids into the soil within 6 hours of application to or placement on the land.
Option 11:	Cover biosolids placed on a surface disposal site with soil or other material at the end of each operating day. (Note: Only for surface disposal.)
Option 12:	Alkaline treatment of domestic septage to pH 12 or above for 30 minutes without adding more alkaline material.

Open-air windrow composting operation near Los Angeles, California.

Option 1: Reduction in Volatile Solids Content

Under this option, vector attraction is reduced if the mass of volatile solids in the biosolids is reduced by at least 38 percent during the treatment of the biosolids. This percentage is the amount of volatile solids reduction that is attained by anaerobic or aerobic digestion plus any additional volatile solids reduction that occurs before the biosolids leave the treatment works, such as through processing in drying beds or lagoons, or by composting.

Option 2: Additional Digestion of Anaerobically Digested Biosolids

Frequently, biosolids have been recycled through the biological wastewater treatment section of a treatment works or have resided for long periods of time in the wastewater collection system. During this time, they undergo substantial biological degradation. If the biosolids are subsequently treated by anaerobic digestion for a period of time, they are adequately reduced in vector attraction. Because they will have entered the digester already partially stabilized, however, the volatile solids reduction after treatment is frequently less than 38 percent.

Under these circumstances, the 38 percent reduction required by Option 1 might not be possible. Option 2 allows the operator to demonstrate vector attraction reduction by testing a portion of the previously digested biosolids in a bench-scale unit in the laboratory. Vector attraction reduction is demonstrated if after anaerobic digestion of the biosolids for an additional 40 days at a temperature between 30° and $37^{\circ}C$, the volatile solids in the

biosolids are reduced by less than 17 percent from the beginning to the end of the bench test.

Option 3: Additional Digestion of Aerobically Digested Biosolids

This option is appropriate for aerobically digested biosolids that cannot meet the 38 percent volatile solids reduction required by Option 1. This includes biosolids from extended aeration plants, where the minimum residence time of biosolids leaving the wastewater treatment processes section generally exceeds 20 days. In these cases, the biosolids will already have been substantially degraded biologically prior to aerobic digestion.

Under this option, aerobically digested biosolids with 2 percent or less solids are considered to have achieved vector attraction reduction if, in the laboratory after 30 days of aerobic digestion in a batch test at 20°C, volatile solids are reduced by less than 15 percent. This test is only applicable to liquid aerobically digested biosolids.

Option 4: Specific Oxygen Uptake Rate (SOUR) for Aerobically Digested Biosolids

Frequently, aerobically digested biosolids are circulated through the aerobic biological wastewater treatment process for as long as 30 days. In these cases, the biosolids entering the aerobic digester are already partially digested, which makes it difficult to demonstrate the 38 percent reduction required by Option 1.

The specific oxygen uptake rate (SOUR) is the mass of oxygen consumed per unit time per unit mass of total solids (dry-weight basis) in the biosolids. Reduction in vector attraction can be demonstrated if the SOUR of the biosolids that are used or disposed, determined at 20°C, is equal to or less than 1.5 milligrams of oxygen per hour per gram of total biosolids (dry-weight basis). This test is based on the fact that if the biosolids consume very little oxygen, their value as a food source for microorganisms is very low and therefore microorganisms are unlikely to be attracted to them. Other temperatures can be used for this test, provided the results are corrected to a 20°C basis. This test is only applicable to liquid aerobic biosolids withdrawn from an aerobic process.

Option 5: Aerobic Processes at Greater Than 40°C

This option applies primarily to composted biosolids that also contain partially decomposed organic bulking agents. The biosolids must be aerobically treated for 14 days or longer, during which time the temperature always must be over 40°C and the average temperature must be higher than 45°C.

This option can be applied to other aerobic processes, such as aerobic digestion, but Options 3 and 4 are likely to be easier to meet for the other aerobic processes.

Option 6: Addition of Alkaline Material

Biosolids are considered to be adequately reduced in vector attraction if sufficient alkaline material is added to achieve the following:

raise the pH to at least 12, measured at 25°C, and without the addition of more alkaline material, maintain a pH of at least 12 for 2 hours; and

maintain a pH of at least 11.5 without addition of more alkaline material for an additional 22 hours.

The conditions required under this option are designed to ensure that the biosolids can be stored for at least several days at the treatment works, transported, and then used or disposed without the pH falling to the point where putrefaction occurs and vectors are attracted.

Option 7: Moisture Reduction of Biosolids Containing No Unstabilized Solids

Under this option, vector attraction is considered to be reduced if the biosolids do not contain unstabilized solids generated during primary treatment and if the solids content of the biosolids is at least 75 percent before the biosolids are mixed with other materials. Thus, the reduction must be achieved by removing water, not by adding inert materials.

It is important that the biosolids not contain unstabilized solids because the partially degraded food scraps likely to be present in such biosolids would attract birds, some mammals, and possibly insects, even if the solids content of the biosolids exceeded 75 percent.

Option 8: Moisture Reduction of Biosolids Containing Unstabilized Solids

The ability of any biosolids to attract vectors is considered to be adequately reduced if the solids content of the biosolids is increased to 90 percent or greater, regardless of whether this increase was for biosolids from primary treatment. The solids increase should be achieved by removal of water and not by dilution with inert solids. Drying to this extent severely limits biological activity and strips off or decomposes the volatile compounds that attract vectors.

The way dried biosolids are handled, including their storage before use or disposal, can create or prevent vector attraction. If dried biosolids are exposed to high humidity, the outer surface of the biosolids will gain in moisture content and possibly attract vectors. This should be properly guarded against.

Option 9: Biosolids Injection

Vector attraction reduction can be demonstrated by injecting the biosolids below the ground surface. Under this option, no significant amount of biosolids can be present on the land surface within 1 hour of injection, and if the biosolids are Class A with respect to pathogens, they must be injected within 8 hours after discharge from the pathogen-reducing process.

The reason for this special consideration for Class A biosolids (assuming vector attraction has not been reduced by some other means) is that pathogens could regrow and Class A biosolids have no site restrictions to provide crop, grazing, and access protection.

Injection of biosolids beneath the soil places a barrier of earth between the biosolids and vectors. The soil removes water from the biosolids, which reduces the mobility and odor of the biosolids. Odor is usually present at the site during the injection process but quickly dissipates when injection is complete.

Option 10: Incorporation of Biosolids into the Soil

Under this option, biosolids must be incorporated into the soil within 6 hours of application to or placement on the land. Incorporation is accomplished by plowing or some other means of mixing the biosolids into the soil. If the biosolids are Class A with respect to pathogens, the time between processing and application or placement must not exceed 8 hours—the same as for injection under Option 9.

Option 11: Covering Biosolids

Under this option, biosolids placed on a surface disposal site must be covered with soil or other material at the end of each operating day. Daily covering reduces vector attraction by creating a physical barrier between the biosolids and vectors. Covering also helps meet pathogen requirements by allowing environmental conditions to reduce pathogens.

Option 12: Alkaline Treatment for Domestic Septage

This option pertains only to vector attraction reduction for domestic septage. Under this option, the pH of domestic septage must be raised to at least 12 and remain at pH 12 or above for a minimum of 30 minutes during which no additional alkaline material may be added.

Common Questions and Answers

Q: Are there any labs certified to perform the necessary pathogen tests?

A: Yes, and the correct analytical methods for pathogens are referenced in Part 503.

Q: For Class A pathogen Alternatives 1 and 2 (which use high temperatures to eliminate pathogens), is it necessary to verify the reduced level of viruses or helminth ova?

A: No.

Q: How often does a permittee have to show compliance with the vector attraction reduction requirements?

A: Compliance has to be shown at the same frequency as pollutant monitoring when vector attraction reduction Options 1 through 8 are met.

Q: Vector attraction reduction Options 2 and 3, which involve additional anaerobic or aerobic digestion, are tied to Option 1, which requires a specified reduction in volatile solids. Is it necessary to fail Option 1 before going on to Options 2 and 3?

A: Failure is not essential. The additional digestion approaches specified in Option 2 for biosolids treated anaerobically and Option 3 for biosolids treated aerobically can be followed without regard to the Option 1 volatile solids reduction requirements.

Q: Does the regulation address odor?

A: Not specifically. Volatile solids are a surrogate. No EPA standards address odor. Odor may be covered under State or local nuisance laws or under air regulations. Odor also may be covered as a special requirement under State or local public health and general welfare provisions.

Q: Are both Class A or B biosolids, in regard to pathogens, protective of public health and the environment, even though biosolids with Class B pathogen status may still contain pathogens and biosolids with Class A status do not?

A: Biosolids with either Class A or Class B pathogen status are protective of human health and the environment because of the added site restrictions and management practices that are required for biosolids with Class B pathogen status, which may contain pathogens. Stated as a generally correct rule of thumb:

Class A ≅ Class B + Site Restrictions + Management Practices.